

FOOD INSECURITY IS RELATED TO INCREASED RISK OF TYPE 2 DIABETES AMONG LATINAS

Objectives: To examine the independent association of food insecurity with type 2 diabetes (T2D), and to identify the T2D risk factors related to food insecurity among Latinas.

Methods: Case-control study in a convenience sample of 201 Latinas (100 cases with T2D, 101 controls) aged 35–60 years and living in an urban setting. Self-reported data, including food insecurity, T2D status, depression symptoms, and socioeconomic, demographic, and lifestyle characteristics (food and alcohol intake, cigarette smoking, physical activity) were collected, and height, weight and waist circumference were measured. Separate multivariate logistic regression models were specified for T2D and food insecurity.

Results: Participants with very low food security were 3.3 times more likely to have T2D (OR 3.33, 95% CI 1.34–8.23) independently of employment status, acculturation, waist circumference, and lifestyle characteristics. High waist circumference (>88cm) (OR 2.46, 95% CI 1.13–5.38) and being in the lowest quartile of physical activity level (OR 3.75, 95% CI 1.21–11.62) were also risk factors for T2D. Elevated depression symptoms and participation in the Supplemental Nutrition Assistance Program (SNAP) were positively related to low and very low food security after adjusting for waist circumference ($P<.01$); cigarette smoking was positively associated with very low food security, and nutrition knowledge was negatively related to low food security ($P<.01$).

Conclusions: These results highlight the need for interventions focusing on prevention of depression and food insecurity among Latinas with T2D. (*Ethn Dis.* 2011;21(3):328–334)

Key Words: Food Security, Hispanic or Latino, Diabetes, Obesity, Depression, Nutrition, Physical Activity, Acculturation

From Department of Nutritional Sciences, Rutgers, The State University of New Jersey; Connecticut NIH EXPORT Center for Eliminating Health Disparities among Latinas (NF) and Connecticut NIH EXPORT Center for Eliminating Health Disparities among Latinas; Department of Nutritional Sciences, University of Connecticut (AHF) and Connecticut NIH EXPORT Center for Eliminating Health Disparities among Latinas; Hispanic Health Council (SSP) and Connecticut NIH EXPORT Center for Eliminating Health Disparities among Latinas; Office of Community Health, Yale School of Public Health (RPE).

INTRODUCTION

Household food insecurity, defined as the limited ability to acquire nutritionally adequate and safe foods in socially acceptable ways,¹ is a growing problem in the United States. Minority groups, especially Latinos, are disproportionately affected by food insecurity. Nearly 27% of Latino households experienced food insecurity in 2009 compared to 11% of non-Latino Whites.²

Food insecurity is associated with poorer health status, including T2D.^{3,4} Low socioeconomic status (SES), certain food intake patterns, obesity, physical inactivity, elevated depressive symptoms, and cigarette smoking have been linked to both food insecurity^{2,5–12} and T2D.^{13–15} Overlapping pathways between food insecurity and T2D may also include cultural characteristics. Acculturation (ie, “the process by which immigrants adopt the attitudes, values, customs, beliefs, and behaviors of a new culture”)¹⁶ has been linked to diabetes,^{17,18} diabetes risk factors,^{19–21} and food insufficiency,²² which considers one dimension (ie, food quantity) of food insecurity.

Although Latinos have substantially higher rates of both food insecurity² and T2D compared to non-Hispanic whites,²³ research examining the potential pathways between these two condi-

inating Health Disparities among Latinas; Office of Community Health, Yale School of Public Health (RPE).

Address correspondence to Nurgül Fitzgerald; Department of Nutritional Sciences; Rutgers, The State University of New Jersey; New Brunswick, NJ 08901; 732.932.3835; 732.932.6522 (fax); nfitzgerald@rce.rutgers.edu

The primary aim of this study was to examine the association between food insecurity and T2D among Latinas.

tions among Latinas is scarce. Most of the previous studies did not examine these associations by race/ethnicity, focused on food quantity only, had statistical power limitations, or did not differentiate between type 2 and type 1 diabetes.^{3,4,24–26}

To our knowledge, this study was the first to examine the associations of food insecurity and T2D in a sample of Latinas while taking into account the potential confounders. The primary aim of this study was to examine the association between food insecurity and T2D among Latinas. The secondary aim was to find out if SES, lifestyle and psychosocial characteristics, and obesity are independently associated with food insecurity and T2D.

METHODS

Study Design and Participants

This was a case-control study conducted among Latinas, aged 35–60 years, ($n=201$; 100 cases with self-reported diagnosed T2D and 101 controls without self-reported diabetes), living in inner city Hartford, Connecticut. Latinas who were pregnant, breastfeeding, or reported having severe health conditions (ie, self-reported cancer, kidney failure) were excluded from the study. Participants were recruited through a variety of methods (street

outreach [32.0%]; telephone directory [20.5%]; Hispanic Health Council [HHC] – a local community service agency – programs [14.0%]; previous study participant lists [12.5%]; health fairs/bulletin boards [7.5%]; schools, health clinics, word of mouth [13.5%]). Interviews were conducted by two trained bilingual interviewers at participants' homes (95.5%), HHC (2.5%) or other locations (2.0%) and in the language of participant's choice (86% in Spanish, 8% in English, 6% in both). Upon completion, participants were provided with a nutrition information packet. The study was approved by the Human Subjects Review Committees of the University of Connecticut and the HHC.

As previously described,¹⁷ the study questionnaire was adapted from valid instruments, translated to Spanish and back translated to English, reviewed by two registered dietitians for content validity, and pretested in the target community for face validity.

Diabetes Status

Participants were classified as having diabetes if they answered the question, "Has a doctor ever told you that you have diabetes?" affirmatively. This question was used in national surveys and showed high reliability ($\kappa=.79$, sensitivity=75%, specificity= 98%)²⁷ and validity (91 to 99% confirmed cases).²⁸ Participants were assigned to the diabetes group after confirming their T2D status through additional questions about their insulin and other medication use, the diagnosing doctor, and the year of diagnosis. Latinas who reported not having diabetes were assigned to the control group and were not asked the diabetes care-related questions.

Anthropometric Measures

Body weight, height, and waist circumference (WC) were measured by the interviewers following standard procedures as previously reported.¹⁷ Body mass index (BMI, kg/m²) was

calculated, and a WC cut off point of >88 cm (>35 inches) was used to classify participants into the high and low WC categories.²⁹

Demographic and Socioeconomic Characteristics

Age (years), ethnicity (Puerto Rican or other Latino), education (low [less than high school diploma]; high [high school diploma/GED/college]), employment status (employed [work full- or part-time]; unemployed [unemployed/homemaker/student/retired/disabled]), having access to a car (yes or no), current SNAP (formerly Food Stamp Program) participation (yes or no), and marital status (have partner, married or common law; no partner) were recorded.

Acculturation status was determined by a 6-item scale (Cronbach's $\alpha=0.73$) that was adapted from a multi-dimensional instrument³⁰ which correlated well with commonly used acculturation variables.^{31,32} The scale included ethnic self-identification, bilingual status, preferred language at home, city size as well as country/territory where the respondent grew up, and length of residence in the United States (split by a median of 20 yr). The acculturation score (range: 0–6, median: 1), was dichotomized into less (≤ 1) and highly (> 1) acculturated.

Food Security

The United States Department of Agriculture's validated³³ 6-item Household Food Security Module³⁴ was used to determine food security status (Cronbach's $\alpha=0.83$). Participants were classified into food secure, low food secure and very low food secure categories based on ≤ 1 , 2–4, and 5–6 affirmative answers, respectively.

Depression

The validated³⁵ 20-item Center for Epidemiologic Studies Depression (CES-D) Scale³⁶ (Cronbach's $\alpha=.95$) was utilized, and each question was scored from 0 to 3 (0=rarely or none; 1=some or little; 2=occasionally or

moderate; 3=most or all the time). A cutoff point of ≥ 16 was used to indicate a high level of depression symptoms.³⁷

Diet and Lifestyle

Dietary intake variables included meal skipping patterns (number of breakfast, lunch, and dinner per week) and an 18-item food frequency questionnaire,¹⁷ which was adapted from a reliable instrument.³⁸ The main food groups were fruits, fruit juice, vegetables, meats, grains, dairy, legumes, salty snacks, regular and diet soft drinks (soft/juice drinks), and regular and diet sweets/desserts. A 25-item nutrition knowledge scale (Cronbach's $\alpha=.81$), including topics such as identifying the nationally recommended number of servings of food groups, sources of fat, saturated fat, cholesterol, and carbohydrates, recognizing fiber and relationships of health with dietary fat and fiber, was used to measure nutrition knowledge.¹⁷ The total score (range: 2 – 20; median: 10) was dichotomized into low (≤ 10) and high (> 10) knowledge categories.

Current cigarette smoking and usual consumption of alcoholic drinks were recorded as yes or no. Physical activities during a typical week over the past one year were determined by questions adapted from the Minnesota Leisure-Time Physical Activity Questionnaire,³⁹ which has been validated in various populations.^{40,41} Leisure-time, household, transportation, and sedentary activities were included, and metabolic equivalent (MET) intensity levels⁴² were used to calculate (sum [MET intensity code \times duration of activity per day]) the total physical activity level as MET-minutes per day (MET-min/d). Quartiles of physical activity levels were generated.

Statistical Analyses

Previous sample size calculations indicated sufficient power to detect group differences in food intake frequencies,¹⁷ and current analyses also

Table 1. Characteristics of Latina adults with and without type 2 diabetes

	Control (n=101)	Diabetes (n=100)
Age, years	47.3 ± 5.9	50.6 ± 6.9†
Ethnicity, %		
Puerto Rican	84.1	85
Other Latino	15.9	15
Education, %		
Less than high school	61.4	66
≥High school diploma	38.6	34
Employment, %		
Unemployed	69.3	74
Employed (part- or full-time)	30.7	26
Marital status, %		
Have a partner (married or common law)	40.6	40
No partner	59.4	60
SNAP participant, %	45.5	51
Food security status, %		
Food secure/low food security§	86.1	74
Very low food security	13.9	26.0*
Acculturation score, %		
High (>median)	54.5	40.0*
Low (≤median)	45.5	60
Obese (BMI >30), %	53.5	70.0*
High (>88cm) waist circumference, %	66.3	81.0*
Physical activity, MET-min/d	1499.7 ± 667.9	1280.4 ± 635.3†
Depression score, mean ± SD	20.4 ± 16.2	21.4 ± 17.1
Elevated depression symptoms (score ≥16), %	53.5	57
Meal intake pattern: skips ≥1 meal/wk, %	87.1	65.0‡
Current cigarette smoker, %	25.7	26
Current alcohol consumer, %	37.6	19.0†

Values are % or mean ± SD.

SNAP, Supplemental Nutrition Assistance Program; MET, metabolic equivalent.

* P<.05.

† P<.01.

‡ P<.001; based on diabetes and control group comparisons using independent samples t test, Mann-Whitney U-test, or Chi-square test.

§ Food security rates were 44.6% and 42.0%, and low food security rates were 41.6% and 32.0% in control and diabetes groups respectively.

suggested adequate power to detect a 12% between group difference in the prevalence of very low food security (Table 1).

Descriptive statistics, bivariate and multivariate analyses were conducted using SPSS for Windows (PASW Statistics) 17.0.2 (2009, SPSS Inc., Chicago, IL). First, differences in group (diabetes vs control) characteristics were examined in bivariate analyses. Then, independent variables (eg, obesity, SES, demographic, diet, and lifestyle characteristics) were entered into a multivariate logistic regression model with T2D

as the outcome. To examine potential moderation effects, first degree interactions of food insecurity with WC, physical activity, and meal skipping were tested. Next, to be able to determine the potential mediating variables and factors associated with food insecurity, diabetes and control groups were pooled together, and multinomial logistic regression analyses were conducted with a similar set of independent variables. Continuous and categorical codings of the scale variables (acculturation and nutrition knowledge) were examined. When results were similar,

categorical coding was used for ease of interpretation. A two-tailed P value of <.05 or 95% confidence interval (CI) of odds ratio (OR) that was exclusive of the value of 1.0 was used as the criterion for statistical significance.

RESULTS

Participants with T2D (versus controls) were approximately 3 years older, less acculturated, and more likely to experience very low food security. The diabetes group participants were also more likely to be obese, be less physically active, and have a high WC but were less likely to consume alcohol or skip meals (Table 1). Food intake differences were limited. The diabetes group participants reported lower intakes of non-green leafy and non-starchy vegetables, and regular beverages/sweets, and higher intake of diet beverages/sweets (data not shown).

After adjusting for age, acculturation, employment, and lifestyle characteristics, Latinas with very low food security were 3.3 times more likely to have T2D in comparison to their counterparts who were food secure or had low food security (Table 2). In this model, participants with high (vs low) WC were about 2.5 times more likely and those in the lowest (vs the highest) physical activity quartile were 3.8 times more likely to have T2D. There was a tendency for less acculturated participants to have a higher likelihood of having T2D. The negative associations of alcohol intake and meal skipping with T2D were most likely the result of reverse causality (ie, change after T2D diagnosis). Cigarette smoking, depressive symptoms, BMI, marital status, nutrition knowledge, education, access to a car, SNAP participation, and interaction (ie, moderation) terms were not significantly related to the likelihood of T2D and thus were excluded from this model.

A separate multinomial logistic regression model, examining the factors associated with food insecurity, revealed

Table 2. Factors associated with type 2 diabetes among Latina adults

	<i>n</i>	OR (95% CI)	<i>P</i>
Very low food security	39	3.33 (1.34–8.23)	.009
Low food security / food secure	157	1.00	
Age	196	1.09 (1.03–1.15)	.003
Less acculturated	104	1.84 (.93–3.64)	.081
More acculturated	92	1.00	
Physical activity MET-min/d			.061
First quartile	49	3.75 (1.21–11.62)	.022
Second quartile	49	1.31 (.45–3.79)	.619
Third quartile	49	1.01 (.40–2.57)	.978
Fourth quartile	49	1.00	
High waist circumference	143	2.46 (1.13–5.38)	.023
Low waist circumference	53	1.00	
Alcohol user	56	.38 (.17–.83)	.016
Non-user	140	1.00	
Skip main meal >1/wk	148	.20 (.09–.47)	.000
Do not skip main meals	48	1.00	

Hosmer & Lemeshow test *P*>.05; Nagelkerke *R*² 33.7%. Adjusted for employment status.

that participants with low food security were more likely to have a high level of depression symptoms, participate in the SNAP, and have low nutrition knowledge in comparison to Latinas who were food secure (Table 3). Very low food security was also positively related to elevated depression symptoms and SNAP participation, and additionally, to cigarette smoking. Further analyses indicated that mean depression scores increased with the severity of food insecurity: 14.7, 24.2, and 28.2 for food secure, low food secure, and very low food secure, respectively (*P*<.001).

After controlling for SNAP participation, the associations of education, employment, car access and marital status with food security were no longer significant. Age, acculturation, physical activity, BMI, meal skipping, and food and alcohol intakes did not result in significant model improvements and were excluded from the final model.

DISCUSSION

Food insecurity has been previously linked to diabetes and its risk fac-

tors.^{2,3,5–15,24} Although Latinos are more likely to have T2D and food insecurity, to our knowledge, our study is the first to examine this association among Latinas while taking moderation effects and other potential confounders into consideration.

The study results showed that Latina adults experiencing very low food security were 3.3 times more likely to have T2D than their food secure or low food secure counterparts after controlling for age, employment status, acculturation, WC, and lifestyle characteristics. This finding is consistent with previous studies, but this study is the first to detect this association after considering moderation effects and other related factors. Previous reports either did not examine this relationship by race/ethnicity, used only food insufficiency, did not differentiate the type of diabetes, or did not control for potential mediating or moderating effects.

Several potential mechanisms may underlie the association between food insecurity and T2D including dietary intake, obesity, physical activity, cigarette smoking, and SES. In regard to diet, there were very few diabetes and control group differences in food intake (eg, consuming diet beverages instead of regular beverages) in this study, but

Table 3. Factors associated with food insecurity among Latina adults

	<i>n</i>	Low Food Security		Very Low Food Security	
		OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>
SNAP participant	97	3.54 (1.75–7.14)	.000	3.18 (1.35–7.48)	.008
Non-participant	104	1.00		1.00	
Elevated depressive symptoms	111	2.51 (1.26–5.00)	.009	3.21 (1.36–7.57)	.008
No/low depressive symptoms	90	1.00		1.00	
Low nutrition knowledge	109	2.44 (1.22–4.86)	.011	1.53 (.66–3.51)	.320
High nutrition knowledge	92	1.00		1.00	
Cigarette smoker	52	1.25 (.55–2.88)	.595	3.74 (1.50–9.30)	.005
Non-smoker	149	1.00		1.00	

Multinomial logistic regression analysis Pearson Chi Square *P*>.05; Nagelkerke *R*² 27.6%. Adjusted for waist circumference.

The study results showed that Latina adults experiencing very low food security were 3.3 times more likely to have type 2 diabetes than their food secure or low food secure counterparts after controlling for age, employment status, acculturation, WC, and lifestyle characteristics.

there might be other intake pattern differences that were not measured, such as cyclic eating patterns (ie, restricting dietary intake during food shortage and excess consumption coinciding with cyclic food assistance benefits).⁴³ The significant association between food insecurity and SNAP participation in the current study suggests further examination of related intake patterns.

Another potential pathway between food insecurity and diabetes can be through obesity. Obesity is a risk factor for T2D,¹³ and national data indicate that women with low food security (vs food secure) are more likely to be obese,^{44,45} and that those with very low food security are more likely to be overweight.⁴⁵ In the current study, WC was not significantly related to food insecurity after adjusting for other characteristics, but it was related to T2D independently of food insecurity. This finding is a new contribution to the literature.

Physical inactivity is another T2D risk factor.¹³ It has been linked to food insecurity in some studies,^{5,11,46} but others do not support a substantial link.³ Current analyses indicated a greater likelihood of T2D among the least physically active Latinas, but physical activity levels did not differ considerably by food security status. Hence, the association between very low food security and T2D was independent of physical activity.

Pathways between food insecurity and diabetes could also involve cigarette smoking. Previous reports from mixed racial/ethnic samples indicated positive associations between smoking and risk of T2D¹³ as well as food insecurity.⁴⁷ Cigarette smoking prevalence in this sample (26%) was high but consistent with a previously reported prevalence (32%) from a similar sample.²⁰ Although cigarette smoking was not significantly related to T2D in the current study, the link between smoking and very low food security was consistent with what has been found in other populations,^{5,47} and

this ethnicity-specific information is a new contribution to the literature. Because smoking rates among Latinas are likely to increase with acculturation,²⁰ the detected link between smoking and very low food security point to a potential opportunity for health promotion and disease prevention.

Previous reports indicated negative associations between various SES indicators and T2D in other populations⁴⁸⁻⁵⁰ although these associations were less consistent among Latinos.⁴⁹ In the current analyses, only SNAP participation was positively related to food insecurity (suggesting adequate targeting of program), and only food insecurity was significantly related to T2D after controlling for other SES characteristics. Thus, the food insecurity measure seemed to capture information above and beyond SES indicators.

Although this study did not find a direct association between T2D and depressive symptoms, there were strong associations between elevated depressive symptoms and food insecurity. This is a new ethnicity-specific contribution to the literature and consistent with other reports involving multi-ethnic samples.^{12,51} Rates of elevated levels of depressive symptoms were high (54% for controls, 57% for cases) but consistent with a previous report from a mixed Latino sample (50%).⁵² Considering the potential bidirectionality between depression and food insecurity¹² and likely lifestyle consequences of both conditions,^{6-8,52} this interconnection should be addressed in future interventions.

Current analyses showed that low nutrition knowledge was associated with greater likelihood of low food security, but it was not related to very low food security. This is a new contribution to the literature. It is possible that nutrition knowledge can protect households against the milder but not the more severe level of food insecurity. Hence, nutrition education can be useful in developing skills to cope with mild food shortages although facilitating access to

healthful foods seems to be essential for very low food secure households.

The limitations of this study include its cross-sectional design. Hence, causality cannot be inferred. Although participants were recruited through convenience sampling, the variety of recruitment methods used successfully captured the ethnic make up of the study location, where about 81% of the Hispanic population were from Puerto Rico.⁵³ Therefore, generalizability of the results is limited to similar populations. On the other hand, a strength of this study is that it provides insights into the associations of T2D with food insecurity and related risk factors in this understudied, highly-vulnerable population, which is the second largest Latino subgroup in the United States. Acculturation is a difficult construct to measure²¹ and may be especially difficult to capture among Puerto Ricans given their unique historical and political relationship with the United States. Thus, it is encouraging that the acculturation measure was internally consistent in our sample.

In summary, the study results indicated a positive relationship between very low food security and T2D among Latinas, and this association was independent of key confounders such as obesity and physical inactivity. Food insecurity was associated with SNAP participation, cigarette smoking, and depression independently of other socioeconomic and demographic factors. These results suggest the need for culturally appropriate interventions focusing on coping mechanisms to prevent depression and food insecurity among Latinas. Longitudinal studies are needed to further elucidate the potential pathways modifying or mediating the relationships between food insecurity and T2D.

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AUTHOR CONTRIBUTIONS

Design concept of study: Fitzgerald, Segura-Pérez, Pérez-Escamilla
Acquisition of data: Fitzgerald, Segura-Pérez
Data analysis and interpretation: Fitzgerald, Hromi-Fiedler, Segura-Pérez, Pérez-Escamilla
Manuscript draft: Fitzgerald, Hromi-Fiedler, Pérez-Escamilla
Statistical expertise: Fitzgerald, Pérez-Escamilla
Acquisition of funding: Fitzgerald, Pérez-Escamilla
Administrative: Fitzgerald, Hromi-Fiedler, Segura-Pérez, Pérez-Escamilla
Supervision: Fitzgerald, Segura-Pérez, Pérez-Escamilla